

# RESIDENTIAL FUEL CELL DEMONSTRATION PROGRAM



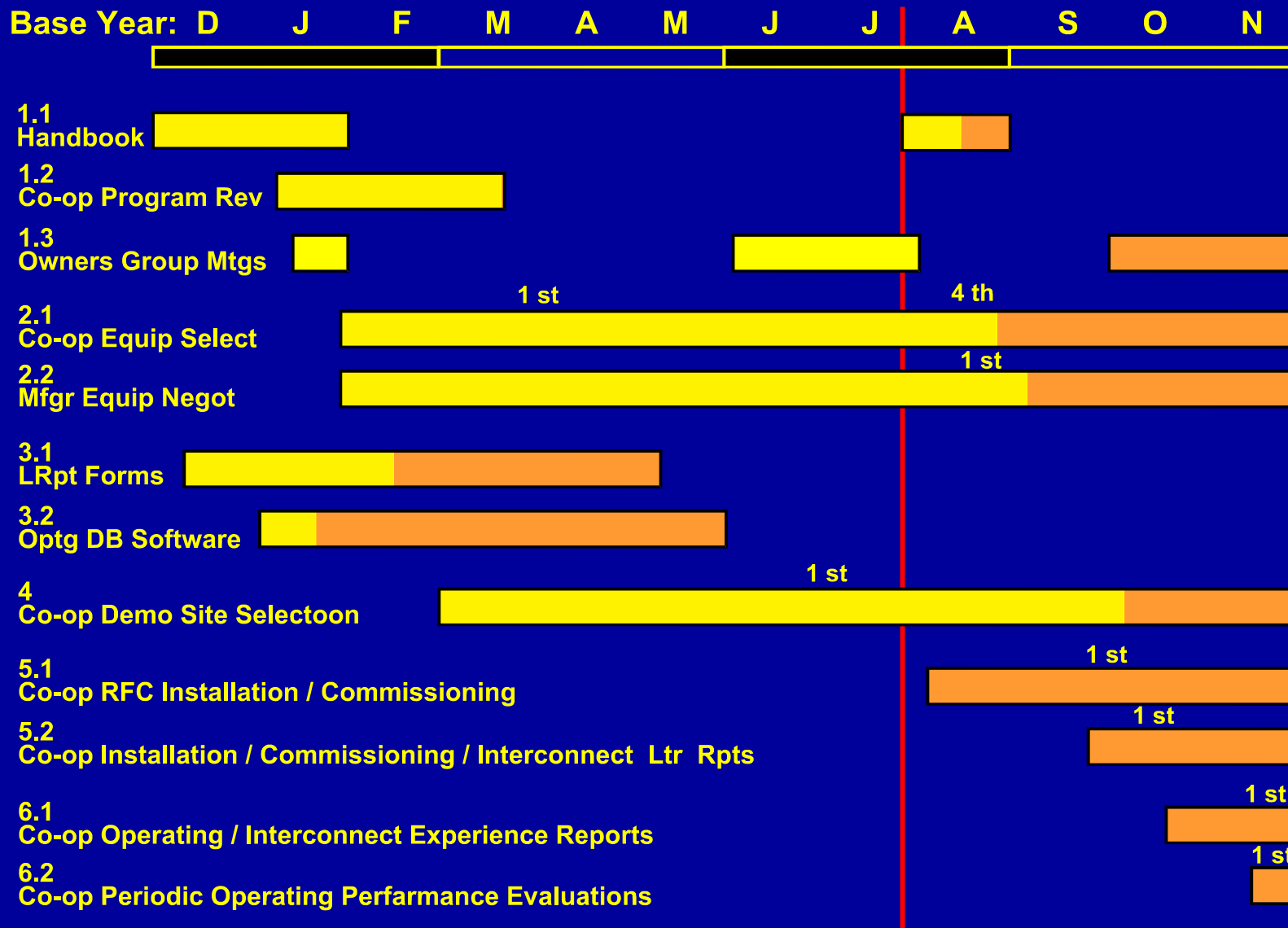
COOPERATIVE RESEARCH NETWORK,  
NATIONAL RURAL ELECTRIC  
COOPERATIVE ASSOCIATION

DoE Distributed Power Quarterly Review Meeting  
July, 2001

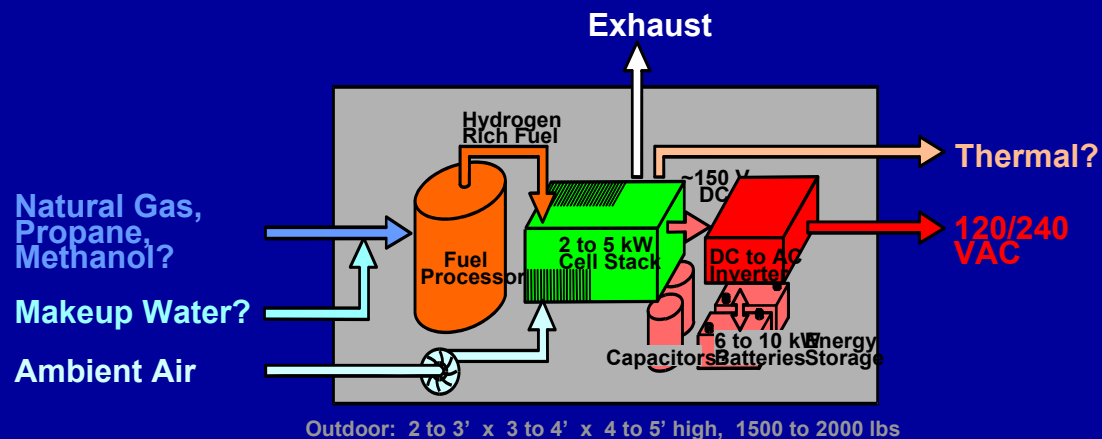
# Co-op Participants . . .



# Tasks and Progress . . .



# Basic Issues . . .



Issue is NOT will RFC's work  
but how long will they work . . . and . . . Price / Markets?

- Life and aging of cell stack
- Reformer life and response
- Inverter load following
- Reliability and maintainability

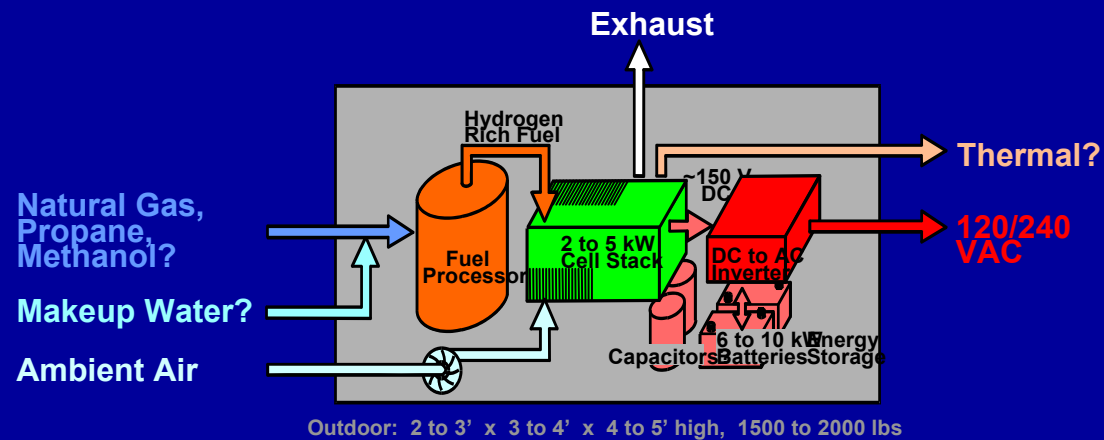
- Application economics vs typical customer size
- Can Mfr's deliver on production-cost curve

# Program Summary . . .

- **Multiple Manufacturers** (Final Spectrum depends on Co-op Selections)

<u>MANUFACTURER</u>	<u>DEMONSTRATION CAPABILITY PROFILE</u>
H Power	4Q 2001 Early production, Energy Co-Opportunity
Inter'nl Fuel Cells	1Q 2002 United Technology, Significant Reformer and FC tech
Plug Power	2001++ Substantial GE and joint venture funding NG-GP First
Avista and inverters	3Q 2002 Modular hot swappable cell substacks

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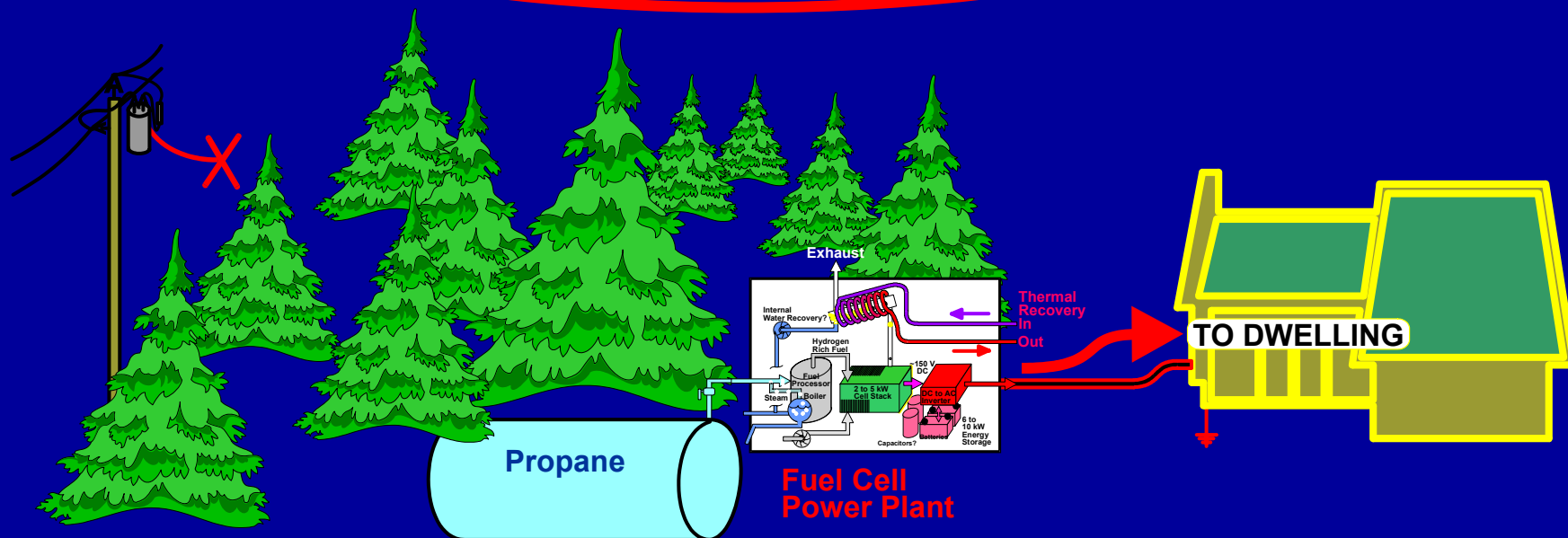
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- Application economics vs typical customer size
- Can Mfgr's deliver on production-cost curve
- **Market Profile**

# Typical RFC Early Entrance Markets . . .

- **Off-grid homes and other off-grid uses**
  - Line extension or single phase service line is \$15,000 to \$20,000+ per mile
  - Difficult, or impossible, to secure right-of-ways in parts of country
- **Home office users**
  - Avoid snow or ice storm interruptions  
(Cost-effective digital satellite now available for telephone and www)
  - Avoid hurricane outages
- **Partial power supply to outage sensitive office and other customers**
- **High income technophiles or “greens”**
- **“Green” or upscale housing developers**

# Best RFC Early Entrance Market . . .

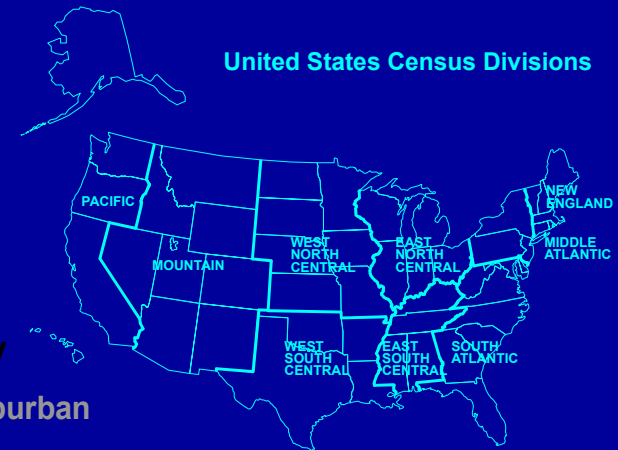
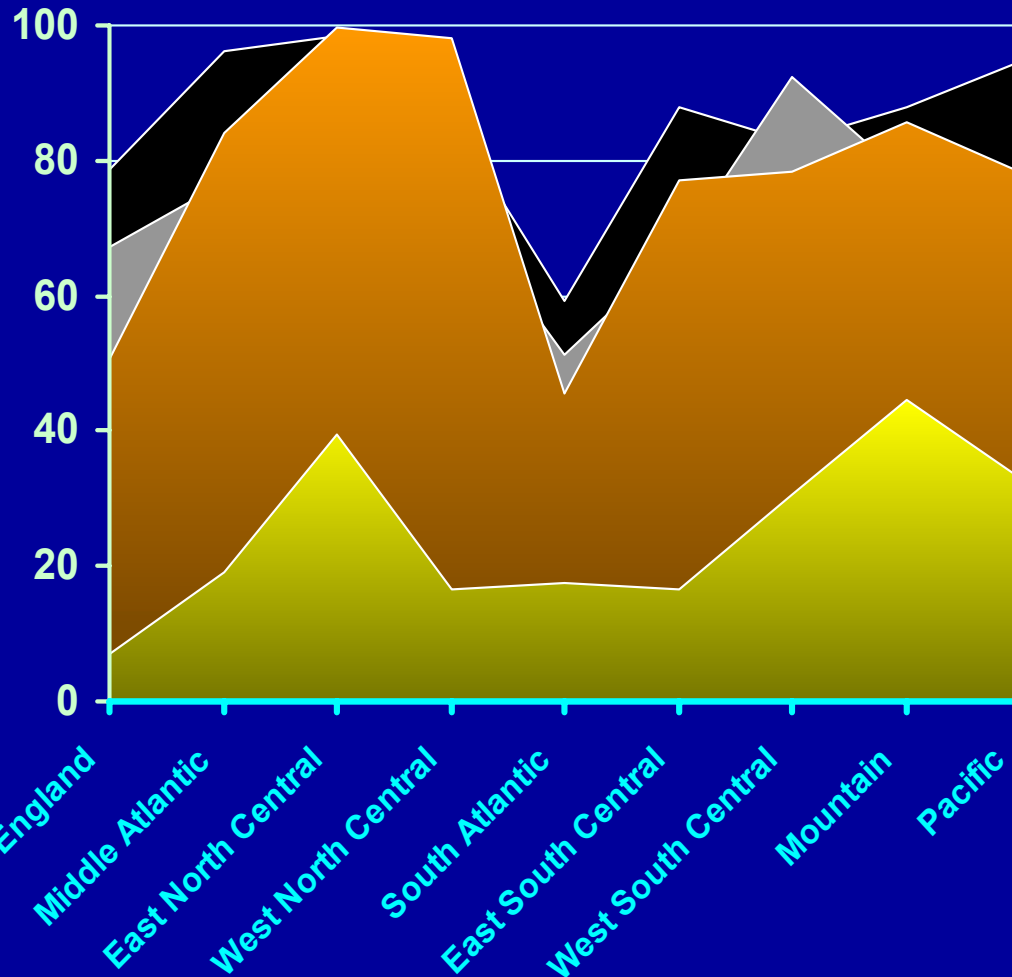
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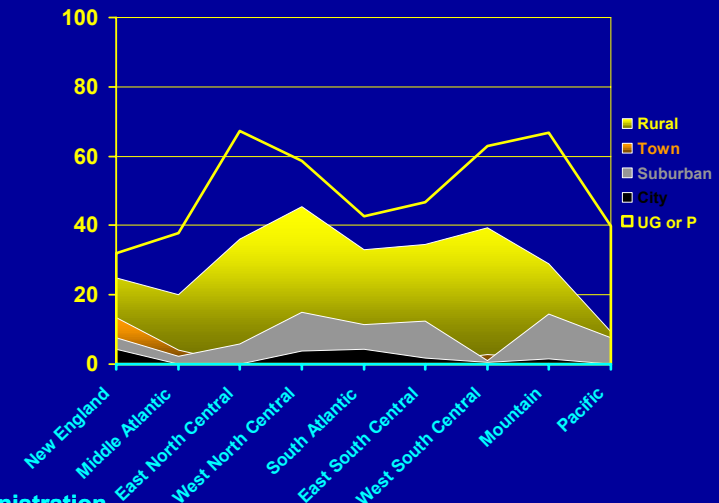


# Propane Needed for Co-ops / Early Mkts . . .

## Percent Availability of Utility Gas








## Percent Availability of Propane



Data: Developed from 1993 National Energy Census by US DoE Energy Information Administration  
by Energy Signature Associates

# Demonstration Plan Update . . .

- CRN Demo Program Briefing Book  January, 2000
- Kick-off Seminar  January 29-31, 2001
- Co-op Decision to Participate  Largely Done
- Co-op Manufacturer Selections Continuing
- Second Users Group Meeting  July 17-18, 2001
  - IFC Mfgr Meeting, Inspection, and Update
  - H Power Beta Experience Update
  - Avista Presentation
  - Motor Start Assessment 
  - Co-op Application Survey

Installation: Late 2001 thru Early 2002

Operation: To End of 2003

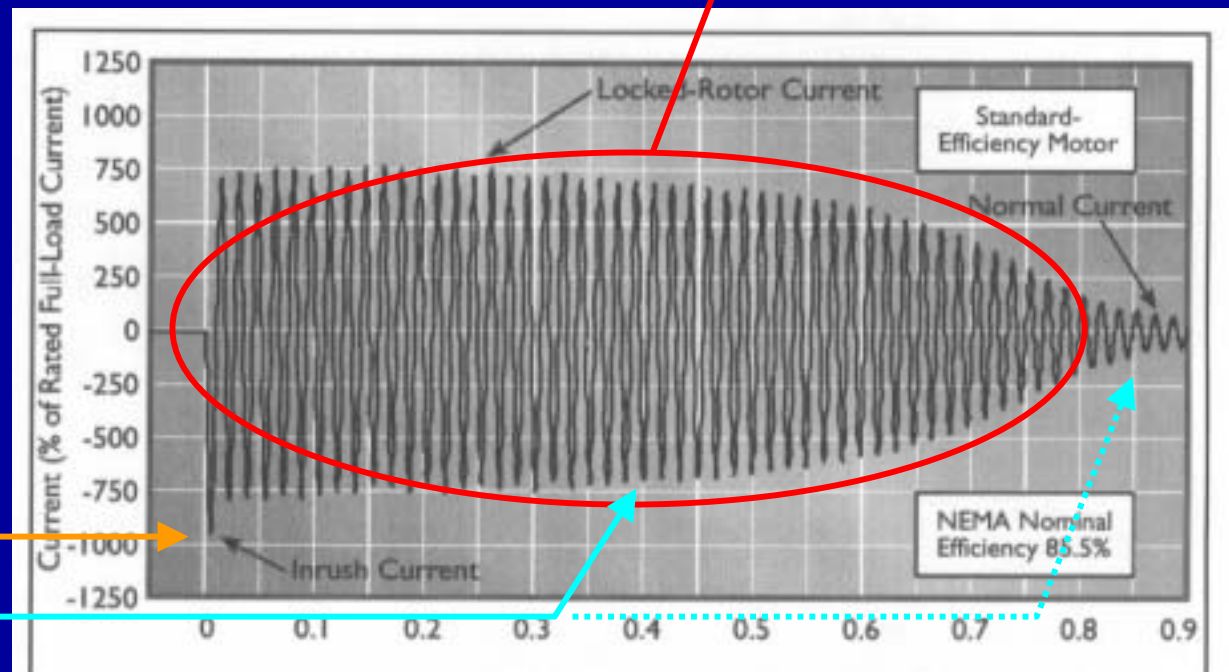
# Motor Start Loads . . .

- Principally a Grid Independent fuel cell issue
- Starting Loads much higher than running loads

Power needed  
to “break” shaft  
loose  
= 9.5X run amps

Power needed  
to accelerate  
shaft to full  
speed  
= 7.5X run amps

Duration and intensity large  
enough to impact RFC inverter  
switching transistors!








Source: PEAC

# Resulting Motor Start Limitations . . .

- **Depends on other major dwelling loads**
  - **“All” Electric:** No chance of Central A/C or Heat Pump
  - **Mostly gas or propane:** Reasonable chance could softstart Central A/C or Heat Pump
- **Also function of customer needs**
  - Off-Grid will likely range from: *Spartan - to - Luxurious*
  - Dual Mode Grid Parallel Home Office, etc.  
*Few hours for thunderstorms - to - days for hurricanes or ice storms*
- **Not much point in pressing RFC mfgs for more capability until market needs better understood**
- **Recently developed \$400 Soft Start add-on's to Heat Pump - Central A/C probably acceptable in interim**

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# CRN Residential Fuel Cell Survey . . .

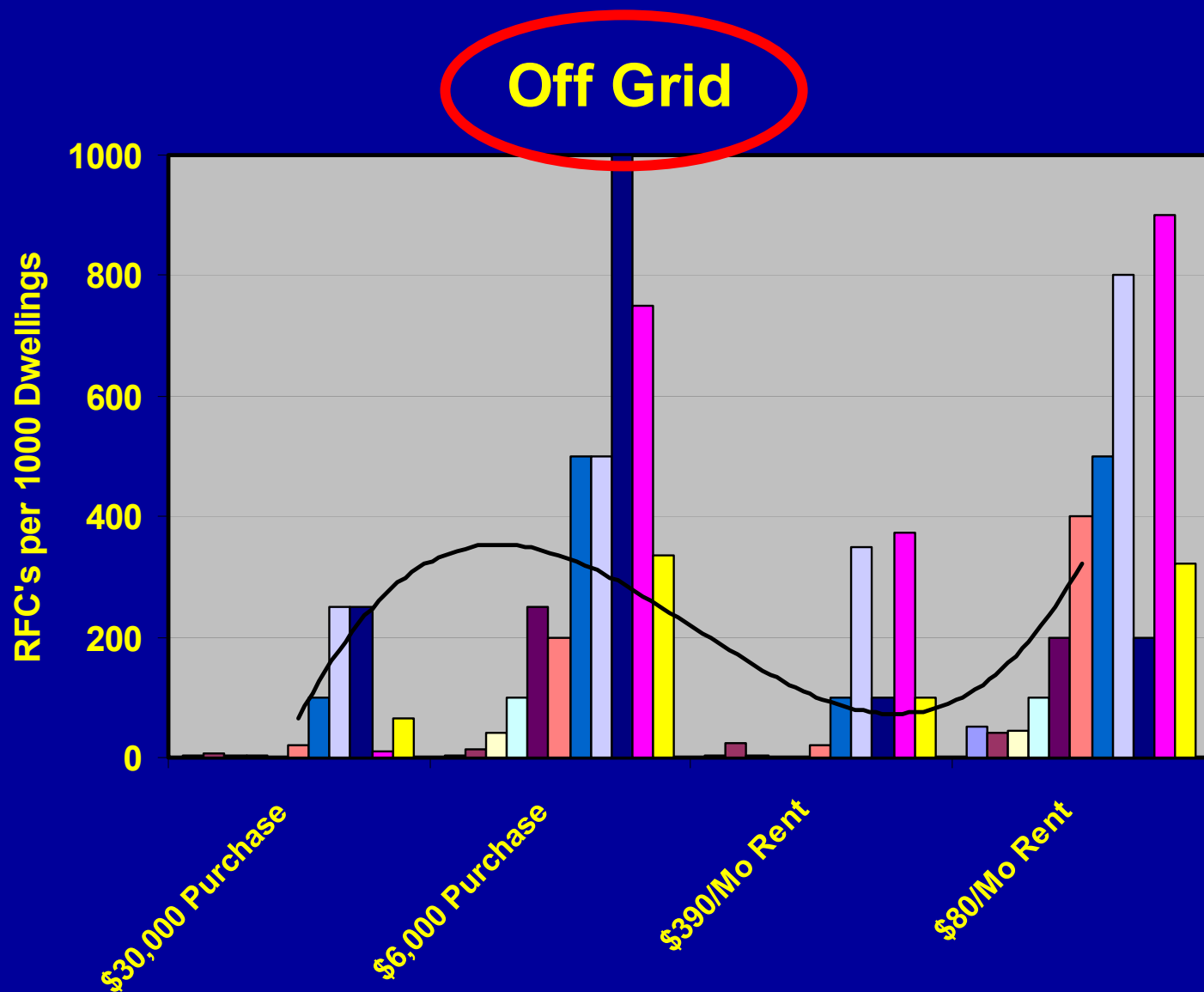
- Multiple co-op respondents, as well as other parties including manufacturers and market implementers
- WWW based
- Survey results from July 7 to July 14, 2001 for co-op respondents
- Extensive group of questions covering all aspects of RFC's such as:
  - Design capacity of unit
  - Likely markets by type and RFC cost impact
  - Interconnect and dispatch
  - Market impact by type of offeror and service provider

# Co-op Profiles and Responses . . .

Location	Residential Customers Served	Typical Residential Electric Rate (¢/kWh)	Percent of Residences w Dist-Serv Lines over 1-Mile Long	Cost per Mile of a 1" Distrib or Service Line	Off-Grid Residences per 1000 Customers		
					Existing	New Added per Year	Records ?
SE	350,000	8.5	5%	\$30,000	0.01	0.00	No
NW	60,000	10	50%	\$105,000	0.8	0.02	No
SW	27,000	7.2	0.5%	\$22,000	27.8	0.93	No
SW	30,000	8	5%	\$50,000	3.3	0.13	No
SE	65,000	8	10%	\$19,000	1.5	0.03	No
Cent	750,000	7.5	3%	\$20,000	4.0	0.13	No
NE	15,000	13	2%	\$25,000	5.0	0.67	Yes
SE	1,700,000	10	5%	\$10,000	Don't Know	Don't Know	No
SE	100,000	6.5	0.5%	\$10,000	1.0	0.05	No
SE	25,400	8	0%	\$24,000	0.1	0.04	Yes

# Projected RFC Mature Market (OG) . . .

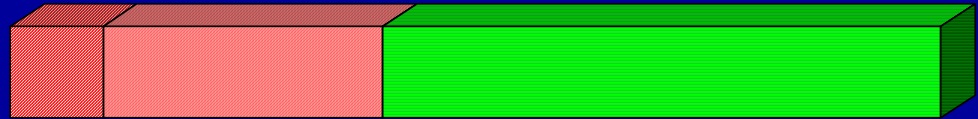
What will be the ultimate use of RFC's in your STATE given that they will be sold by Local Appliance Dealers? >>>



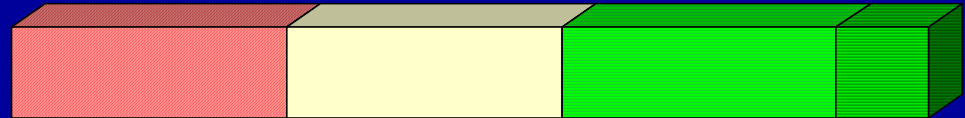


# Grid Parallel Operations (sample from survey) . . .

GP: OK to rely on the grid for SOME CONTINUOUS DAY-TIME power load



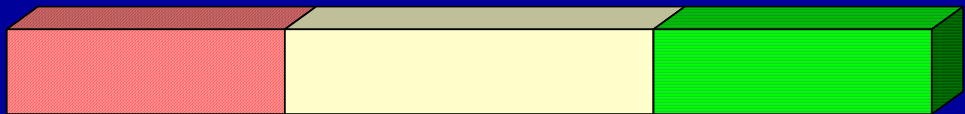
GP: OK to export power to the grid during the DAY TIME



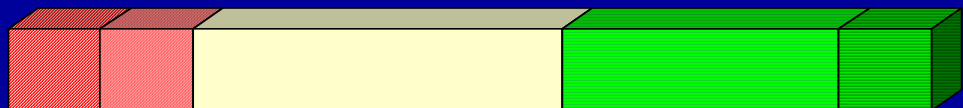
GP: OK to rely on the grid for SOME intermittent MOTOR START DAY-TIME load



GP: Should include built-in CO-OP CONTROLLED REMOTE DISCONNECT SW even if adds \$400 to price



GP: If RFC meets IEEE anti-islanding stds, built-in co-op controlled Remote Disconnect Sw is NOT needed



Strongly  
Disagree

Disagree

Neutral

Agree

Strongly  
Agree



# Thank you

# Questions?